

EXPLORING DOMINANCE: PREDICTING POLITIES FROM CENTRES

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Sociopolitical organisation is not the same as economic organisation, and social space differs from the spatial ordering of markets and other spatial features of market economy. This chapter starts with a specific underlying problem in archaeology: the reconstruction or prediction (retrodiction) of sociopolitical organisation from archaeological data. How can we use settlement remains, as documented archaeologically, to formulate the social and political configurations which helped to generate them, and were influenced by them?

The investigation hints at regularities in the spatial patterning of society which remain to be explored, and in particular in the absolute size of the political territory which an autonomous centre of a given population size can expect to exploit. Such cross-cultural regularities, if documented, would have a significance well beyond the confines of archaeology.

The general background to the problem has been treated in the previous paper (chapter 2) and six axioms developed:

- 1) The human social group is defined by the habitual association of persons within a territory.
- 2) Human social organisation is segmentary in nature: human spatial organisation is therefore cellular and modular.
- 3) Basic social groups do not exist in isolation, but affiliate together into larger groups, meeting together at periodic intervals.
- 4) Human society is often hierarchical in nature: human spatial organisation is therefore stratified.
- 5) The effective polity, the highest order social unit, may be identified by the scale and distribution of central places.
- 6) Special interactions between polities undoubtedly take place, creating uniformities in artefact distribution: such uniformities in

themselves do not document societies or peoples.

Our aim in undertaking the work discussed here was to investigate the fifth of these in particular.

It should be stated clearly that our outlook owes little to classical central place theory of the geographers (Christaller 1933, Lösch 1954). It is an alternative approach to the question of human spatial organisation, making none of the assumptions about 'economic man' and his behaviour (many of them no doubt entirely valid) underlying central place theory. It has much more in common with the perspective of Soja (1971).

The following assumptions are made:

- 1) Politics have continuous territorial jurisdiction over their domains, without intervening parcels of land.
- 2) A piece of land is normally under the jurisdiction of a single autonomous authority (and, where appropriate, its deputies within a hierarchical structure). This does not necessarily exclude areas of no-man's land, where territorial authority is not exercised.
- 3) 'Capitals,' the autonomous administrative centres of independent sociopolitical polities, are in general the largest settlement or administrative sites within the territories of their polities. (Cases in which the 'capital,' the seat of administration of the polity, is not the largest settlement or administrative centre, often reflect clearly identifiable special factors: most of them are artificial creations, summer palaces, or federal capitals reflecting the rather sophisticated device of a voluntary association of states.)
- 4) There is some positive correlation between the size of the autonomous 'capital' centre (whether measured by area or by population) and the territorial area of the polity over which it has control.

We make no initial assumption about the precise relationship indicated in assumption 4 (or 'hypothesis' 4). It should be particularly noted that we do *not* assume that settlements above a given arbitrary size all rank as autonomous centres whereas those below do not. In this respect our analysis differs fundamentally from that of most archaeologists using central place considerations, including Johnson (1972 and 1975). Likewise the writings of Berry (1961) and Crumley (1976) concerning the primate city, although of very real interest and relevance, do not focus upon precisely the problem we consider.

Our investigation is limited at present to sedentary societies: the formulation, as stated here, is not applicable to nomadic or other mobile groups.

The model is applied in the first instance at a given time: it is static. But when successive time points in a settlement system are considered, and changing political configurations and boundaries predicted, it becomes dynamic. Indeed the model could be linked with some procedure to predict the growth of centres (not attempted here) to foretell changing political boundaries and the conflicts that accompany them.

Problems in Reconstructing the Territories of Polities

Consider the landscape of autonomous polities, each with at least one permanent settlement within its territorial boundary. The existence of some measure of territoriality is assumed, although the boundaries could well be 'fuzzy' (for fuzzy sets cf. Zadeh 1965) with overlapping at territorial extremes (cf. Soja 1971, fig. 8). These polities may range from relatively simple acephalous societies whose principal settlement is a single village to highly complex nation states with populations measured in millions.

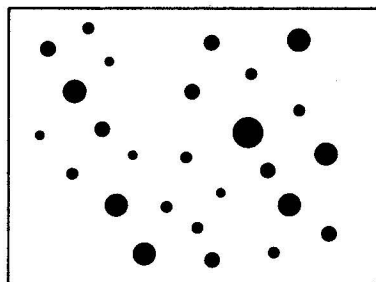


Figure 1. A settlement distribution. The size of settlement is proportional to the area of the dot.

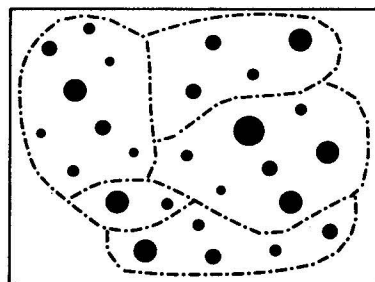


Figure 2. Political divisions associated with the settlement distribution of figure 1. Territorial boundaries are indicated by the broken lines.

We imagine a settlement distribution (figure 1) in which there are several settlements within the confines of each polity. In the archaeological case, let us suppose that no prior evidence remains for the political organisation or the arrangement of territories (figure 2). The problem is to reach some reconstruction of these.

If the archaeological sites were in contemporary use (and this is an important condition), a first approach might be to construct Thiessen polygons around each (figure 3). Each piece of land would then be allocated the jurisdiction of the settlement nearest to it. This ignores, rightly or wrongly, the size of the centres as well as any

hierarchical arrangement among them. Several examples of such a procedure may be found in the literature (e.g., Renfrew 1973, 133), all assuming, explicitly or implicitly, the absence of hierarchy.

This procedure can be modified, for instance by means of weighted Thiessen polygons, so that the territorial area is dependent on the size of the centre (cf. Hogg 1971).

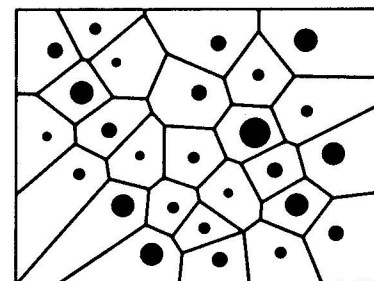


Figure 3. Unweighted Thiessen polygons giving a notional territorial division for the settlement pattern of figure 1. The archaeologist will often draw such a map as a provisional first attempt to reconstruct the territorial divisions of figure 2 from settlement data.

So far, however, no account is taken of *dominance*. For only in the most strictly acephalous societies are there no sites which are subordinate to others in the political or administrative hierarchy. But how are we to decide which sites dominate which? The opposite extreme to that seen in figure 3 would be to assume that the largest centre dominates all others, giving a single unified polity. The solution offered by some workers (cf. Johnson 1975) is to take sizes of centres in rank order, in the hope of finding some discrete separation between large (viewed as dominant, independent capitals) and small (seen as subordinate, second- or third-order locations). But in many cases, as envisaged earlier, this just does not work. To take an example from modern Europe, the population of Belgrade, the capital of Yugoslavia, is less than that of the seventh largest centre in the United Kingdom. Standard geographical extensions of the rank-size rule are not in practice appropriate. What if there are no convenient breaks between first- and second-order centres, nor any 'primate' capitals, larger by an order of magnitude than their nearest rivals within the polity?

The answer lies in considering dominance within a spatial context, rather than in isolation in terms of size alone. It is necessary to assert some relationship of size and distance, whereby the larger

dominates the smaller if the distance between them is sufficiently small, whereas the smaller retains autonomy if that distance is great. In effect we assume some law of monotonic decrement (cf. p.136 below) for political influence, and hence for the dominance of capital centres. We assert that some such relationship everywhere held until the development of near-instantaneous communication methods (radio) and rapid, militarily effective air transport.

The XTENT Model

As a trial formulation, and nothing more is claimed here, we assume that the influence of a centre is proportional to a function of its size, and declines linearly with distance:

$$I = f(C) - k \cdot d \quad (I \geq 0) \quad (1)$$

where I is a measure of the potential political influence of a centre at a location x , C is a measure of the size of that centre, d is the distance between x and the centre, and k is a constant.

Any location x will fall within the territorial jurisdiction of the polity whose centre exercises the greatest influence at x . In particular, if the location x is the location of a centre C_2 , a neighbouring centre C_1 will dominate location x and thus C_2 if $I_1 > I_2$ at location x ; that is, if

$$f(C_1) - f(C_2) > k \cdot d_{1,2} \quad (2)$$

where $d_{1,2}$ is the distance between the two centres.

The position is seen in figure 4. The influence of each centre is indicated on the y axis, and declines linearly with distance from the centre, reaching zero at the point where $f(C) = k \cdot d$. The second centre, C_2 , by virtue of its position, is subordinate to C_1 , while C_3 , which is the same size as C_2 , remains autonomous. The more distant centre C_4 , although actually the smallest in size, likewise remains autonomous. There is an area of no-man's land between the territories of C_4 and C_5 .

We have found it convenient to think of this as a 'tent pole' model, the dominance of a centre being comparable to a radially symmetrical bell-tent with the size of the centre governing the height of the central pole (figure 5). Those smaller settlements whose own tents can be pitched entirely within the bell-tent of their larger neighbour are dominated by that neighbour. Those whose central pole would protrude beyond the surface of the tent are the centres of autonomous polities.

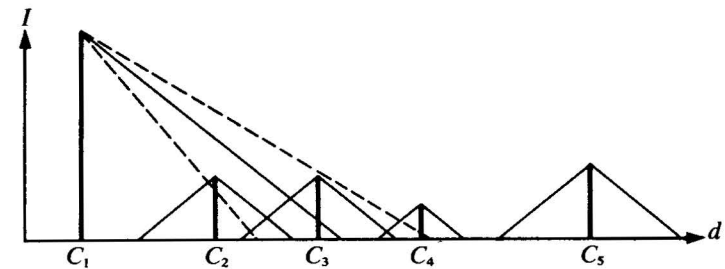


Figure 4. The XTENT model, with influence of centre as ordinate and distance as abscissa. Five centres are shown along a single line, the size of each indicated by a thick vertical line. The radius of domination for each is given by the intersection of the solid line with the $I = 0$ axis (the dashed line indicates the effect of varying the slope). Note how C_2 is entirely dominated by C_1 whereas C_4 , although smaller in size, has its own independent territory.

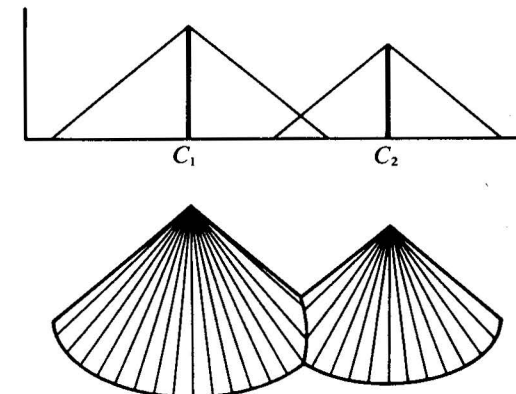


Figure 5. The XTENT model, with (above) distance along a single line joining two centres (as in figure 4) and (below) a three-dimensional sketch showing how the influence exerted by the two centres may be represented by two intersecting radially symmetrical bell-tents.

This formulation, which we claim as the simplest conceivable approach to the problem of dominance, without the prior assumption of specific hierarchical levels, allows us to work with a single variable, k , the slope of the fall-out of influence (i.e., of the tent).

It is a central tenet of our approach that the value of k is not assumed, but is to be investigated empirically until general rules for its size can be formulated. It is at once inherently obvious that development in transport facilities, such as the introduction of the

horse or the railway, will reduce the value of k .

Distance d may be measured as simple linear distance, or *transformed* (for instance into travel time) to take account of varieties of terrain. Our initial formulation considers political control on land, and initially makes no distinction between terrestrial and marine distance. Further elaboration, using a suitable transformation for marine distance, would allow this over-simple assumption to be adjusted.

The approximate measure of 'size' is a practical archaeological problem to be approached empirically in each case. If figures were available for population, this might be the best measure. Alternatively, area of settlement may be used, although this presents several practical problems familiar to archaeologists. Other possibilities would be the number of coins issued by a mint (if a polity may contain more than one mint centre), the size of ceremonial monuments at the centre, or any other plausible construct from the archaeological data. Clearly the validity of each measure has to be critically evaluated for each case.

The other element of choice, in addition to the value of k , concerns the function $f(C)$. We have worked with the formulation $f(C) = C^\alpha$, experimenting with different values of the exponent α , and measuring C in terms of either population (known) or area (estimated).

The most convenient allocation of territories to centres develops naturally from this model. Centres or settlements that have been 'dominated' by others have no independent territory (at this level of analysis). Any location is assigned to the centre whose influence upon it, as defined earlier, is greatest. If this location is not dominated by any centre (i.e., the location does not lie under any tent), then it is left politically unassigned: the location is in 'no-man's land.'

Boundaries then occur in one of two ways. Either a boundary is a line of minimum influence between two centres, or else it is a line of division between 'no-man's land' and a region under domination by some centre. Thus the first type of boundary falls along the furrows created by the intersection of tents, whereas the latter type falls along the edges of tents where they meet the ground.

The model thus allows the creation of hypothetical political maps, using only the location and size of settlements (or other centres) as input information, and generating political divisions without any prior knowledge of them.

The Computer Program and Display

The computer utilized was the PDP 11/45 of the Institute of Sound and Vibration Research at Southampton University (with interactive graphic facilities). This permitted both immediate interactive display and hard-copy graphic printout. The program, in FORTRAN, requires three data files for each case studied.

The first file, INPUT FILE (COORDS), lists the coordinates, in pairs, of all location (settlements, centres, monuments, or whatever) under consideration.

The second, MAP OUTLINE FILE, gives in coordinate form the map boundary data which it is desired the computer should display. For instance, the simplified map of Europe, seen in figure 9, is drawn by the computer from a file with coordinates for 283 points of coastline.

The third file, POP FILE, gives the measure for the size of different centres (which in the first case examined was the population, and in others area) in the same sequential order as their coordinates in INPUT FILE.

Using the data in the INPUT FILE and POP FILE, the program examines each centre, checking it for dominance by neighbouring centres. If a centre is not dominated, it will have a boundary surrounding its political territory. The program marks such a centre as autonomous, computes the boundary location, and draws it in.

If a centre is dominated, it will not have a political boundary of its own since our model permits only autonomous centres to have independent political territories. The program marks such a dominated centre as non-autonomous and omits it from any future calculations.

After all boundaries have been drawn, the autonomous centres are displayed with a given sign (in this case, a cross) and the dominated, subordinate centres falling within their territories by a square. Where appropriate the map outline is then automatically added from the MAP OUTLINE FILE.

A normalisation factor is used, by which the sizes of all locations are divided: in general it is the size of the largest centre in the series.

Various values of the exponent α were selected, in general between 1.0 and 0.125. A high value of α leads to the dominance of the entire area by the single largest centre; a low value of α tends toward local autonomy by levelling out the size differences.

During the course of the investigation the program was modified to give with each hard-copy map a value for the number of autono-

mous centres, for the average nearest neighbour distance between autonomous centres, and for the average maximum radius of centres (i.e., the arithmetic average taking in turn the maximum distance attained between the boundary of each polity and its centre).

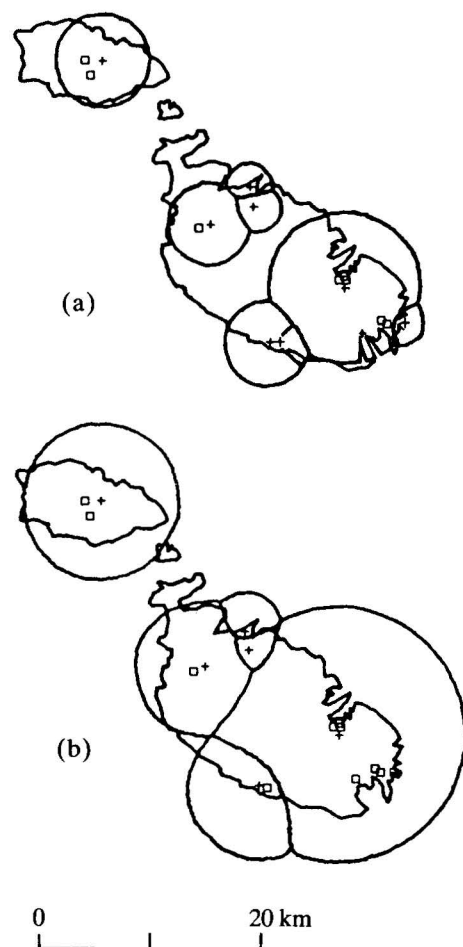
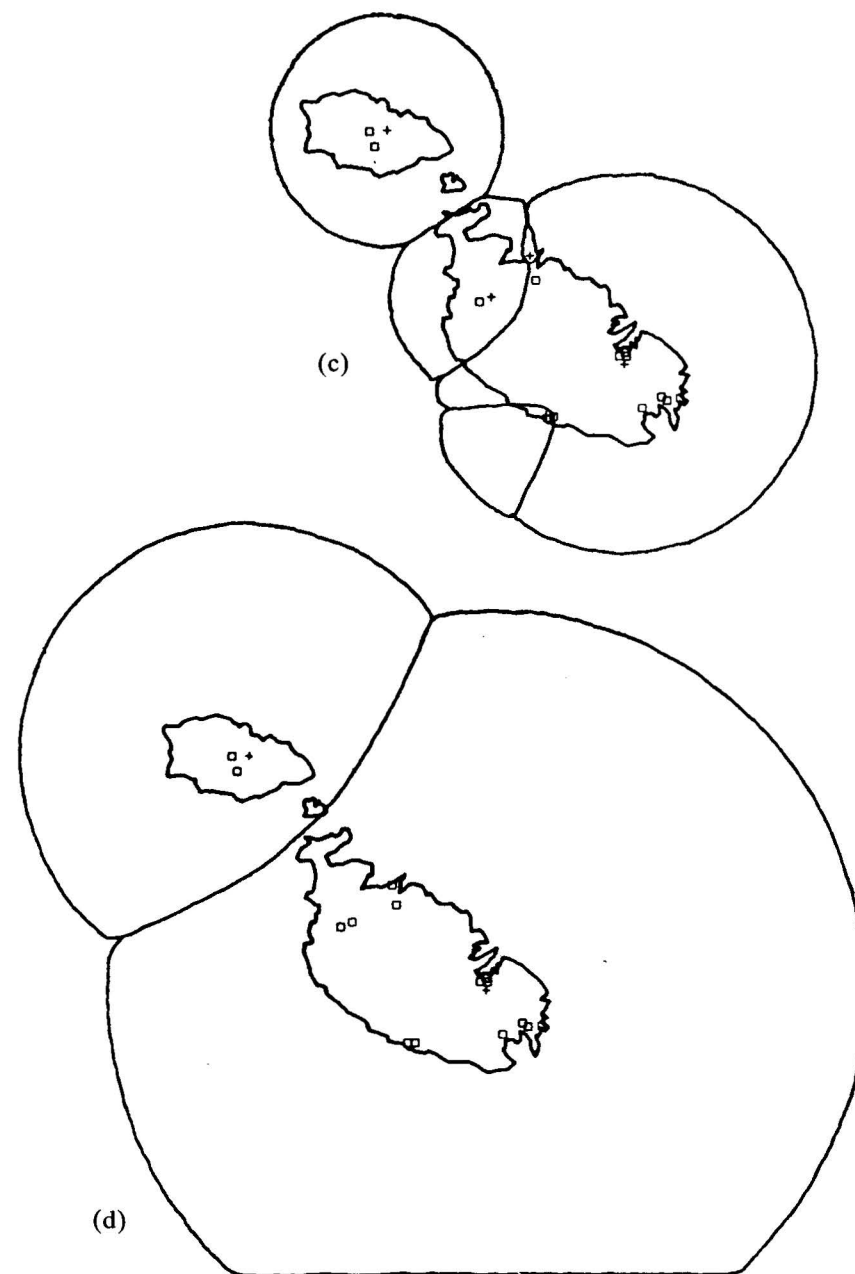


Figure 6. Computer graphic maps of territorial divisions in neolithic Malta. Temples are indicated by a cross when an autonomous centre, by a square when subordinate. The slope parameter varies: (a) 0.05 (b) 0.03 (c) 0.02 and (d) 0.01. The exponent is 0.5 throughout.



Experiment 1: Malta

One of our first experiments involved the distribution of neolithic temples on the island of Malta (Evans 1971), dated to the approximate time range 3500 to 2500 BC. Few prehistoric settlements have been found on Malta, but these impressive stone monuments are well known. The appropriate measure of size was taken to be the area enclosed by stones, for which $\frac{1}{2}l^2$ (with l as the longest dimension) was taken as a convenient approximation. It had been suggested that groups of temples reflected some hierarchical organisation, with territorial division by chiefdoms (Renfrew 1973, 154), and it was hoped that the model would offer some insights in this direction. Of course the assumption should be explicitly stated that the area occupied by the temple buildings reflects in some measure the power, influence, and size of the parent community, and that its location lies within the residential territory of that community. These assumptions are certainly questionable in this case, and so must be any conclusions about prehistoric Malta derived from the model. As a simple test case for the method, however, the example is a convenient one.

The computer was given (a) coordinate pairs for the locations of the 17 sites in question, (b) an estimate for the area of each, and (c) 221 pairs of coordinates read manually to give a digitized coastline for the islands of Malta and Gozo. This last is for display purposes only and plays no part in the computations, which take place as if the locations were on an isotropic plain.

For the first run, the exponent α was set at 0.5 (i.e., the computer worked with the square root of the area actually occupied by each site). This area in each case was first normalized by dividing by that of the largest temple: in effect, for convenience we start by adjusting the size of the largest location to unity. The slope parameter was then allowed to vary in steps of 0.01 from 0.05 to 0.01 (see figures 6a-d).

The computer then printed out autonomous and subordinate centres and territorial boundaries in each case. The greatest (i.e., steepest) slope corresponding to the sharpest fall-off in influence with distance, naturally produced the largest number of autonomous locations and the smallest number of 'captures' by dominance. The relationship of the number of autonomous centres to the slope is seen in figure 7. The linear relationship in equation (1) postulated for distance means that boundaries, except where two territories touch, are circular in form. Outside the boundary the effect of the

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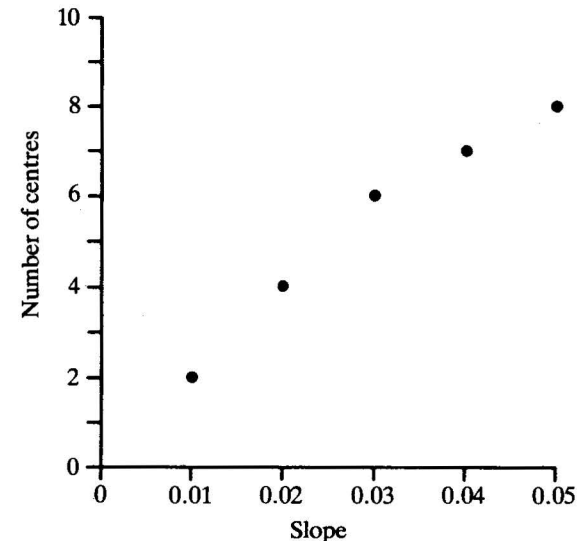


Figure 7. Relation between the number of autonomous centres and the slope parameter for the Maltese temples.

centre in question is zero. This differs from the Thiessen polygon approach, where the entire region is divided up, influence being inversely proportional to distance. With weighted Thiessen polygons an inverse square relationship can be used, which in formal properties is related to Reilly's gravitation relationship (Hodder and Orton 1976, 188).

Gradual reduction in slope produces the assimilation of progressively more locations into larger political units, and offers a fascinating caricature for the evolution of a hierarchical political system from an egalitarian one. It should be noted that the initial hypothesis is strongly supported by the persistent association of several small groups of sites, including the group of three on the northern island of Gozo, dominated by the great Ġgantija temple, the temples of Mgarr and Skorba in northwest Malta, and the grouping of the three Kordin temples in every case with the great centre at Tarxien. An interesting feature of the model then is that varying the slope changes certain aspects of organisation, while leaving others invariant.

As a second experiment, the slope parameter was now fixed at 0.05, using the same data set, and the exponent α varied, by a factor of 2 in each case, from 1 to 0.125 (figures 8a-d). An exponent of

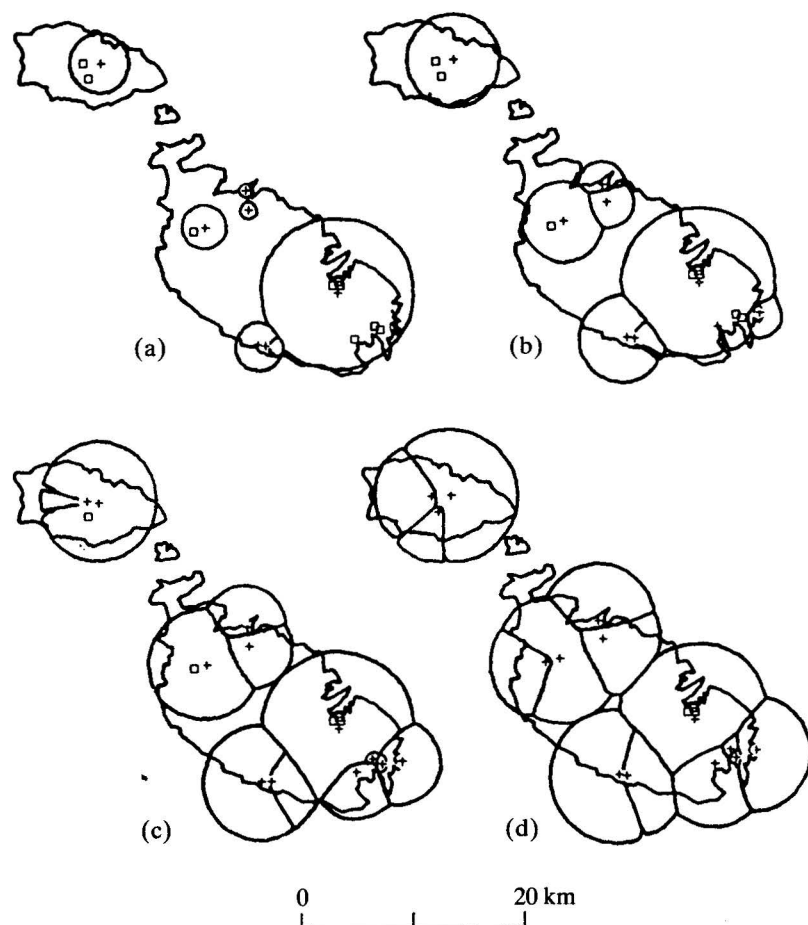


Figure 8. Territorial divisions in Malta with varying exponent α : (a) 1.0 (b) 0.5 (c) 0.25 (d) 0.125. The slope parameter is 0.05 throughout.

0.125 implies that the eighth root of area is being taken for the magnitude of each site, the largest site (at Tarxien) being regarded throughout as unit size. The territorial sizes of smaller sites therefore increase with decreasing exponent, and when $\alpha = 0.125$ there are no fewer than 14 autonomous centres, since the eighth root of each is itself close to unity and they become effectively of almost equal size. But the map 'looks wrong' because of the distortions, so

that individual centres are no longer near the middle of their territories. Here perhaps the experiment suggests to us a criterion for selecting an appropriate value of α .

This and other experiments have shown, in a rather pragmatic way, that an exponent of 1 allows the larger centres to dominate the smaller to what seems an untoward extent, whereas an exponent of less than 0.25 produces what look like territorial distortions. No doubt both these statements require further substantiation. In most subsequent work we have used an exponent of 0.5. This has the consequence, when we use area as a measure of size for a centre, that we are comparing linear measure for territory (radius) with linear measure for centre (root area). The territorial area dominated by the site is thus proportional to the area actually occupied by the site itself. Likewise, when we use population, we are thinking of root population as proportional to radius of territory, and hence (by squaring) population as proportional to territorial area.

Experiment 2: Cities of Europe

In order to test the model against a case in which real political boundaries are accurately known, population sizes for the 117 cities in Europe in the year 1960 whose population exceeded 500,000 (Showers 1973, 260–286) were listed, together with their coordinates, and a digitized coastline for Europe. With an exponent of $\alpha = 1$, there were large areas of no-man's land between territories for all values of the slope greater than 0.1, and once again an exponent of $\alpha = 0.5$ was chosen as more appropriate. The resulting configurations for values of the slope parameter between 0.006 and 0.020 are seen in figures 9a to 9d. The relationship between slope and number of autonomous centres is seen in table 1. Each centre of a given population size has a maximum radius of influence, determined by the slope, although naturally when centres lie close together their common boundary falls within their theoretical radii of influence. For a given slope, any city of population one million will have the same radius of influence. Moreover, when the exponent $\alpha = 0.5$, the radius of influence for a population of 10,000 will be precisely one-tenth of that for population one million. These figures are also seen in table 1. Note that the figures given in the first column of tables 1 and 2 and on the abscissa of figures 7 and 10 are convenient parameters which are inversely proportional to the physical parameters listed in column 3 of the tables.

It should be noted that no distinction was made between distance over sea or over land. Had maritime distance been seen as an

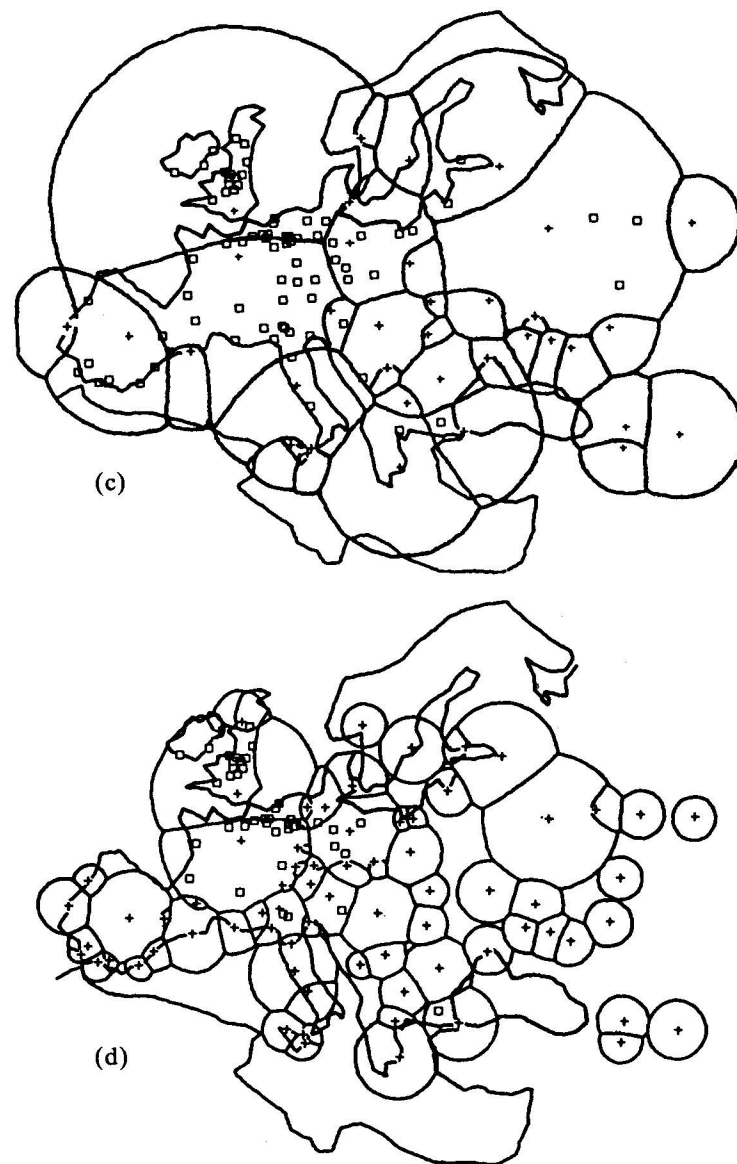
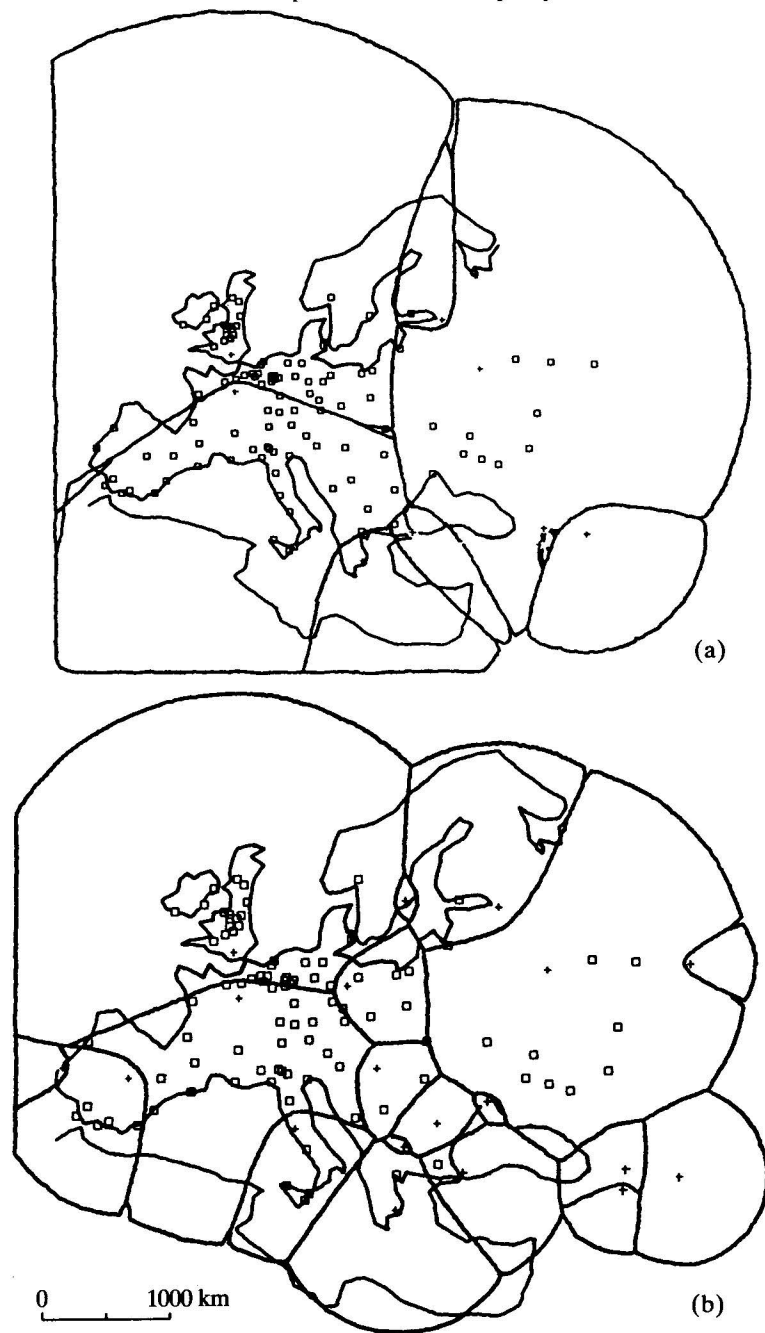


Figure 9. Computer graphic maps of European polities in AD 1960 as predicted by the XTENT model. The exponent α is 0.5 throughout. The slope parameter varies: (a) 0.006 (b) 0.010 (c) 0.014 and (d) 0.020.

Table 1. The effect of varying the slope on the number of autonomous centres and on the radii of influence for the cities of Europe in 1960 ($\alpha = 0.5$).

Slope parameter	Number of autonomous centres	Radius (km)	
		For 1,000,000 population	For 10,000 population
0.006	9	1166	116.6
0.008	15	875	87.5
0.010	19	700	70.0
0.012	29	583	58.3
0.014	36	500	50.0
0.016	45	437	43.7
0.018	47	389	38.9
0.020	53	350	35.0
0.030	73	233	23.3
0.040	86	175	17.5

obstacle to effective domination, the jurisdiction of Paris would have extended in each case to the coast of the English channel.

A second apparent distortion is the tendency toward autonomy of a number of areas within the USSR. For instance, in the case in which the slope parameter is 0.006, Tbilisi, Baku, and Yerevan emerge as the capitals of autonomous provinces. But as so often in such cases, the exceptions prove interesting in themselves: the computer is mischievously predicting the autonomy of the Transcaucasian People's Republics of Georgia, Azerbaijan, and Armenia. This need not give comfort to separatist movements: it is a first instance among many on these maps where we appear to see a configuration appropriate to one time period appearing also at another.

Clearly the two maps approximating most closely to the actual political reality are those for which the slope parameter is 0.014 (36 autonomous centres) and 0.010 (19 autonomous centres). The relation between the slope parameter and number of centres is seen in figure 10. In the latter case, London, Paris, Madrid, Lisbon, Rome, Athens, Istanbul, Moscow, Stockholm, Berlin, Budapest, Sofia, and Bucharest all acquit themselves appropriately (Istanbul since Ankara, lying outside Europe, is not included). The odd-men out, apart from the three Transcaucasian provincial centres, are Leningrad – a city whose former capital status is notable – and Odessa and Ufa in the USSR.

Predicting Politics from Centres

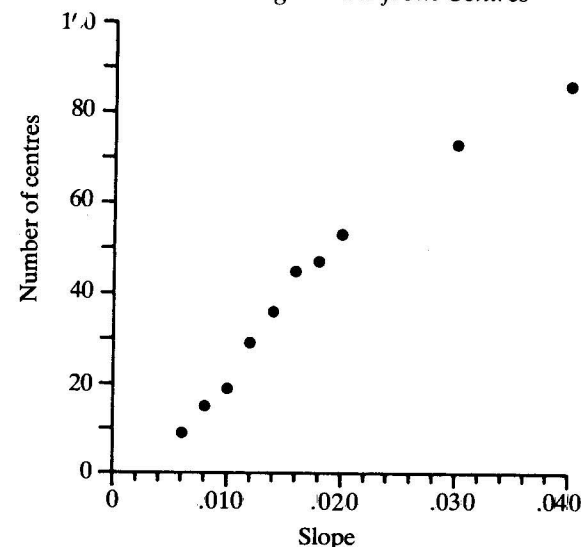


Figure 10. Relation between the number of autonomous centres and the slope parameter for the European cities.

In the case in which the slope parameter α is 0.014, Belgrade, Vienna, Oslo, Copenhagen, and Warsaw are now among the territorial capitals, while Syracuse and Palermo recall earlier Sicilian autonomy, and indeed the short-lived Kingdom of the Two Sicilies, and Barcelona, the old independence of Aragon. An alarming number of localities in the southern USSR emerge as independent: paradoxically this is because of their relatively small population size, or rather the late date at which this part of Europe became fully urban.

It is intriguing that when the slope parameter is 0.020, we see what approximates to a return to the Middle Ages (in western Europe) with separate status for former polity centres such as Naples, Valencia, Cordoba, and Seville. In effect the program is now including second-order centres, such as Glasgow and Belfast, and particularly notable is their manner of grouping themselves around the major, first-order centres which already emerge when the slope parameter is 0.006.

Turning now to the first of these maps, with slope parameter 0.006 we see indeed a Europe of great powers, reminiscent in some ways of the situation at the time of the Napoleonic wars, when Britain and France were the major competitors, yet with the retreat

from Moscow clearly implied. Both Waterloo and the battlefields of the Peninsular War (in Iberia) are appropriately under British influence. Athens and Istanbul give us a hint of the Eastern question.

These comments, not all entirely serious, do reflect the important generalization already made in the case of Malta, that alteration in the slope for a given distribution may in some respects mimic the effect of the passage of time.

Experiment 3: Late Uruk Settlement

To illustrate the approach as applied to archaeological settlement data derived from survey, the program was applied to the Late Uruk settlement system in the Warka area of Mesopotamia. The settlement areas have been conveniently listed by Johnson (1975, 312–14), and location coordinates were measured from his map (ibid. 316). His data are derived from the survey by Adams and Nissen (1972) and we follow him in including 98 of the 118 sites listed by Adams and Nissen. It was necessary to assume an area for Warka itself, since this had not been estimated. In fact separate runs were undertaken for areas of 40, 60, and 80 ha, respectively, and the discussion here relates to that for an area of 60 ha.

Table 2. The effect of varying the slope on the number of autonomous centres and on the radii of influence for the Uruk area in the Late Uruk period ($\alpha = 0.5$)

Slope parameter	Number of autonomous centres	Radius (km)	
		For 1 ha	For 100 ha
0.005	4	7.95	79.5
0.010	18	3.97	39.7
0.020	44	1.99	19.9
0.030	62	1.32	13.2

The exponent α was held at 0.5 throughout, and the slope parameter was given successive values of 0.005, 0.01, 0.02, and 0.03. The results are seen in table 2. As before, the computer determines which sites dominate others, in terms of their size and location, indicating the territory of dominant 'capitals' and the locations of the subordinate settlements. As slope is decreased, all the settlements gradually become subordinate to larger centres, until only the largest is autonomous. As slope is increased, smaller and smaller centres emerge as 'independent.' In an egalitarian political

situation the latter may approximate to the political reality. But when the administration is in reality hierarchical, the increase in slope leads to the appearance of subordinate second-order centres as autonomous.

Figure 11 shows the configuration with the slope parameter set at 0.01. The autonomous settlements are indicated by a cross. In addition we have used arrows to indicate the four centres which already emerge as autonomous when the slope parameter is 0.005. Here then we are in effect beginning to use an overlay of the configurations for different slopes to give an indication of internal, hierarchical structure within polities.

It is instructive to compare this with the configuration at which Johnson himself arrived (1975, 332) as a result of his locational analysis (figure 12). By plotting a histogram for area of settlement he divided settlements into four size classes: large centres, small centres, large villages, and villages. Using classical central place theory concepts he regarded the settlement distribution as a modified hexagonal lattice (assigning special significance to sites at which ceramic wall cones have been found, considered as indicating a temple).

Of the five settlements classified as large centres by Johnson, four emerge as autonomous centres at slope parameter 0.005, and the resemblances between the two interpretations are obvious. Our program tends to grant autonomous status to middle-size settlements located far from others, and this has occurred with the two located at the southeast of the area. Likewise, our program underlines the potential significance of the centre at the northwest (Johnson's 'small centre' no. 020). It is difficult to see why this was omitted from his lattice. Moreover, the six centres arranged between it and the two large centres to the south (nos 242 and 125) have very much the appearance of second-order locations in a settlement hierarchy and might well have responded to his central place approach.

Our program does not, in itself, tell us which of the alternative political configurations it produces (according to change in slope) is the most appropriate. This depends on the distance over which a centre of a given size can exert effective influence (see the last column of table 2), which is inversely proportional to the slope. If a given distance (and slope) does effectively lead to a representation of the political reality, steeper slopes will give an insight into a structuring within polities, whereas smaller slopes predict supra-national spheres of influence.

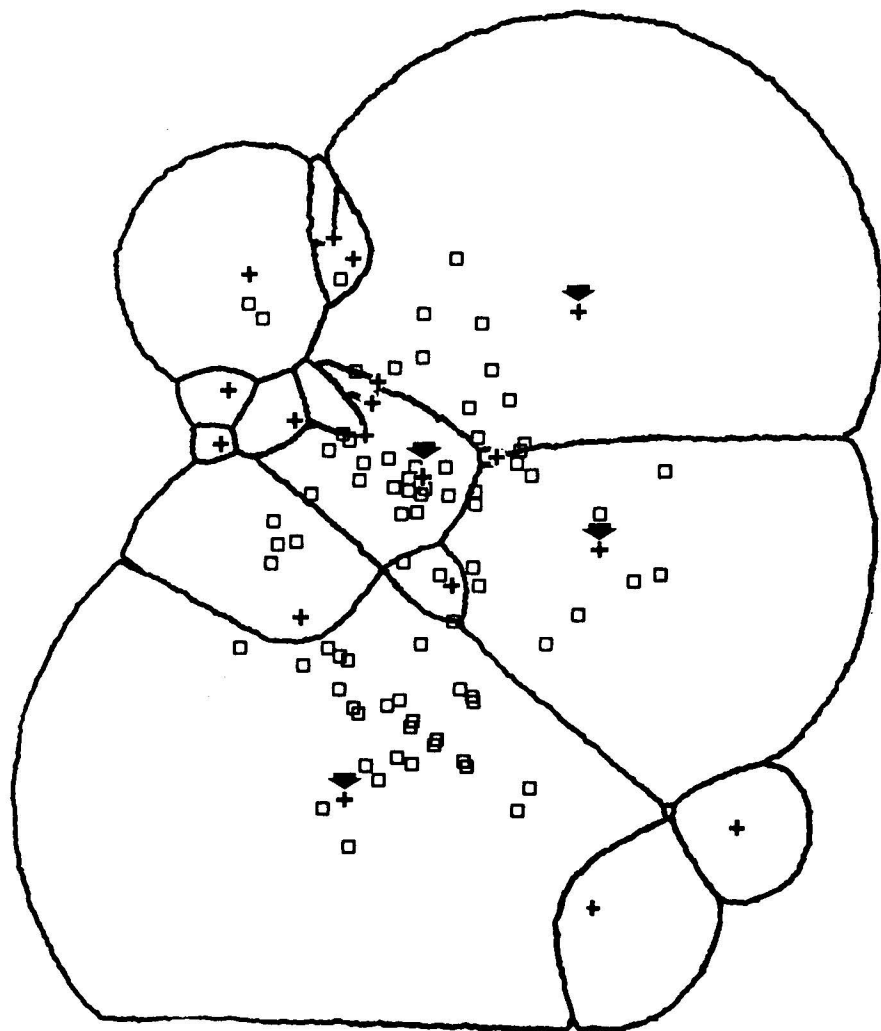


Figure 11. Predicted political divisions for the Late Uruk period in the Warka area of Mesopotamia (exponent $\alpha = 0.5$, slope parameter 0.01). Arrows indicate the four centres that emerge as autonomous with slope parameter 0.005. Compare with figure 12, shown on the same scale.

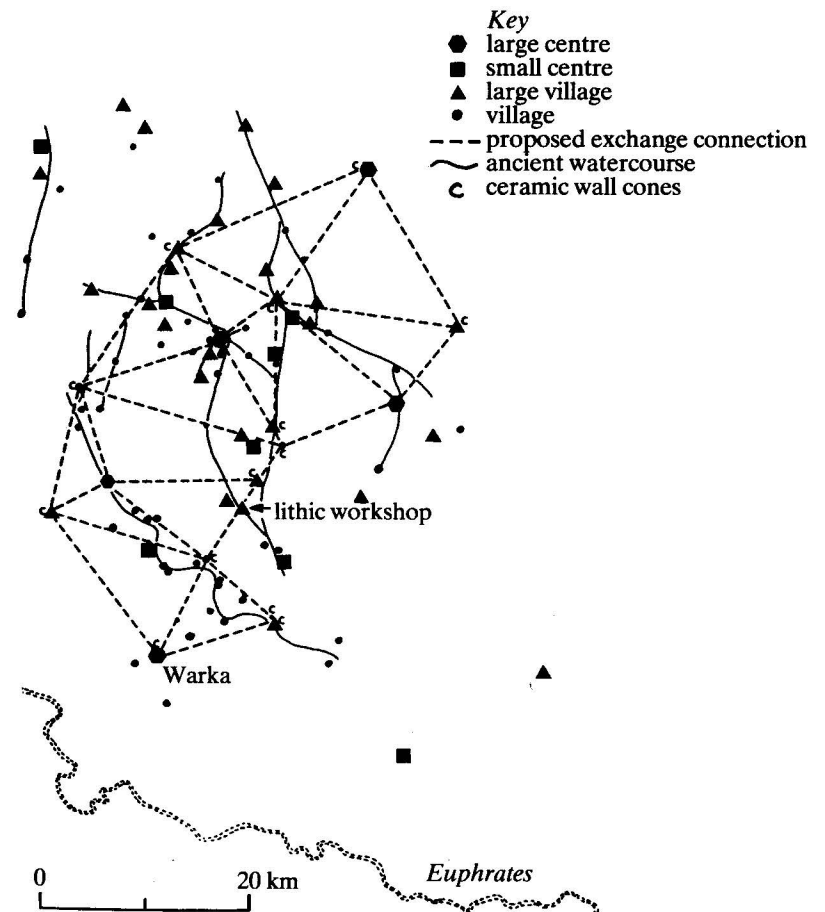


Figure 12. Settlement structure of the Late Uruk period in the Warka area as analysed by Johnson (1975, 332). Note the similarities with figure 11, which is on the same scale.

The XTENT Model as a Framework of Comparison

Our experiments, which included further examples not cited here, suggest that although a widely appropriate value of the exponent may be found ($\alpha \approx 0.5$), there is no easy or *a priori* means of judging the 'right' slope.

We would claim, however, that the very concept of 'slope' in this sense, expressed in absolute terms, may offer a conceptual advance. Accepting for the moment that the appropriate value for the exponent is agreed, we have in the slope a *single* variable which will uniquely determine the political landscape. For convenience we have spoken here using normalized values (such as 0.01, 0.02) without absolute units. But in table 2 the appropriate absolute units were given for the Uruk pattern, and may be compared with those in table 1 for European cities in 1960. Obviously direct comparison is possible only if we know the approximate population in Uruk times for a town whose area was 100 ha (or know the mean area for a town of 100,000 in modern Europe). But if we use, for the basis of argument, an urban population density of 100 ha⁻¹ for Mesopotamia in the Uruk period, the last columns of the two tables become directly comparable. Indeed figure 10 (Uruk settlement, with 100 ha seen as influencing a radius of 40 km) may be compared with figures 8c and 8d (Europe 1960, with centres with a population of 10,000 influencing 50 and 35 km, respectively).

Such comparisons can at times be misleading. Transport factors, overall population density, and degree of urbanisation must all have their effects. Moreover, although the exponent $\alpha=0.5$ may be appropriate as a first approximation, it remains to be tested that a city with a population of one million has in fact a sphere of influence precisely 10 times the radius of a town of 10,000 population, or that town a radius 10 times the radius of a village of 100 ha.

Yet we would argue that these are precisely the questions that have to be asked. To what extent do the same parameters of distance and magnitude operate in the classic Maya lowlands as in Sumer, for instance, or in the Mississippian as in the European Iron Age? It may be that the XTENT model, and others like it, will offer a more rigorous framework for cross-cultural comparisons than has been available hitherto and hence open the way at last to a systematic and diachronic comparative study of human societies. [1979]

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II

TRADE AND INTERACTION

*

Until the 1960s the discovery of objects in one area which clearly originated from a distant source was frequently used to arrive at inferences about cultural 'influences', and was generally interpreted within a framework of diffusionist explanation. Here, as I showed with several examples in *Problems in European Prehistory* (Renfrew 1979), the source of innovation was generally seen as external to the culture area under study. In Europe, therefore, objects imported from the Mediterranean were viewed as highly significant indicators of the workings of the diffusion of culture. Artefacts supposedly imported from Western Asia and found in India and Pakistan, or even further afield, were assigned a similar significance, and the same patterns of reasoning were applied in other areas of the world. For instance, objects found in pre-Columbian north America which resembled in any way those of Mesoamerica were regarded as indications of the influence of the 'higher' cultures upon the lower, and the detection of actual goods of demonstrably southern origin was regarded as even more significant.

All of this was a product of 'normative' thought, where 'influences' of one area upon another were to be measured in terms of the similarities recognised between artefacts in the two areas. As noted in chapter 1, it fitted very well into the predominantly diffusionist explanations almost universally prevalent at that time.

Increasing scepticism about this broadly diffusionist framework, aided in prehistoric Europe by the collapse of the traditional chronology under the impact of radiocarbon dating (Renfrew 1973) led to a very different outlook. There was now a less ready acceptance of inconclusive evidence for contacts between distant areas, and the mere recognition of similarities between specific artefact forms in each no longer led to automatic assumptions that the two had been in contact. In this more critical atmosphere, positive and incontrovertible demonstration that contact of some kind had taken place was all the more interesting, and it could generally only come from the documentation that specific objects had indeed travelled very

far from their place of manufacture or from the original source of the raw material. For this reason the scientific *characterisation* of materials – that is to say the recognition of physical or chemical characteristics by which the constituent material can confidently be ascribed to a specific source – became particularly useful. For now it was possible to call into question the provenance of *any* supposedly imported object, and in favourable cases to receive an unequivocal answer.

The focus of interpretation now shifted away from the simple diffusionist notion of cultural 'influence', even when contact between the two areas in question really could be documented by means of characterisation studies. It moved instead to the social and economic processes which led to and sustained the exchange transactions responsible for the movement of the goods in question, and to the consequences of those processes. These questions could best, it was felt, be approached through a study of the distribution patterns of the traded materials themselves, and in chapter 5 the way in which these can be generated as a result of different patterns of exchange is considered.

What these papers do not sufficiently discuss, however, is the range of social mechanisms within which the trading systems in question operate in specific societies, nor the effects upon the societies of these trading systems within them. One specific model of this kind, for instance, has been widely influential. It stresses the possible control in the trade of prestige goods by the local élite of a region, and the effects of this control in strengthening the position of the high-status individuals forming the élite, and ultimately perhaps in elevating them from a position of petty chiefs to one of much greater power within a more centralised society. This model was first developed by Flannery for the Olmec of Central America (Flannery 1968), and very much the same approach was taken by Frankenstein and Rowlands (1978) for the development of very prominent ranking in the south-central European iron age (see also Wells 1980).

There is a risk of circularity with some of these arguments. In some cases the basic data consist of no more than the existence of rich graves containing a number of imported goods. From this the existence of an élite is quite plausibly inferred, and the suggestion made, often without much supporting evidence, that they controlled the processes by which the exotic materials were obtained. From there it is an easy, but not altogether persuasive step to propose that the élite status of the individuals in question is not only

documented by these goods but is actually to be explained by them. Despite these possible difficulties, the merit of this explanation is that it sets out to consider in some detail the social context of the goods exchanged in a specific way, rather than merely considering the quantities of imported materials found (see also Rowlands 1980).

Another recent approach, with which I am less in sympathy, has been to regard the presence in a region of a few traded objects deriving from a more industrially advanced society as indicative of the existence of what Immanuel Wallerstein has rather misleadingly named a 'world system' (Wallerstein 1974). Wallerstein's main example comes from the West Indies in the sixteenth century AD, when the economy of the area was indeed so dependent upon that of western Europe that it is entirely sound to regard them together as forming part of a single economic system. (The term 'world' does however seem misleadingly general, even where transatlantic relationships are under consideration.) But when this model is translated back to the first or even the second millennium BC, and the countries of western Asia are seen as the counterparts in economic domination of sixteenth century western Europe, and the prehistoric lands of Europe are compared with the later West Indies as subservient components of the system, the analogy goes altogether too far. Indeed at this point the reasoning seems to have gone full circle, and we are right back to the diffusionist position of Gordon Childe (1958), with his theory of the economic domination of Europe by Mycenaean Greece. Now as then, the Marxist view of the domination of the natives by colonial and capitalist urban centres requires more than simple assertion: it needs a rather more dispassionate study of the social relations within which the exchange systems were embedded, based upon a thorough review of the actual data. Without this it is no more than resuscitated diffusionism.

A more fruitful approach touched on in chapter 4 is the consideration of information flow alongside the material exchanges which can be documented by characterisation studies. Moreover the thrust of much recent work is to consider the effects of exchanges of information as well as material *within* a given region, and to regard these as potentially at least as important as more far-flung exchange transactions. The idea of the single region containing a number of effectively autonomous social units, already discussed in chapter 2, is relevant here. In the case of early state societies it is sometimes possible to speak of Early State Modules. Work undertaken since this paper was written has suggested that it is the interactions

between polities of roughly equivalent size within a region which can be of decisive importance in governing the trajectory of development within it. The significance of such peer polity interactions, as they have been termed (Renfrew 1982, 287) in the development of many early societies, not all of them so complex in their structure as early states, is a matter of current discussion (Renfrew and Cherry, in press).

In this field, as in others, there have been several programmatic articles advocating a 'contextual' or 'structural approach', and arguing, quite reasonably, that a much more detailed understanding of the specific properties of the exchange system in question is desirable in each case (e.g. Hodder 1982). It is easy to share this view, as a general aspiration, and indeed it holds much in common with the broadly neo-Marxist approach of Frankenstein and Rowlands, and the earlier analysis of Flannery, mentioned above. Quite clearly, when it is widely recognised that different commodities are traded in different 'spheres of exchange' (Dalton 1977), it is pertinent to seek some understanding of the relative values assigned by the societies in question to the commodities which they were trading. But this is not a new question, and despite systematic consideration in one of the pioneer works of processual archaeology (Winters 1968), this is not a field where there have been striking insights recently.

The problem is highlighted in chapter 5, where it is shown that in some cases very different exchange mechanisms could produce closely similar patterns of artefacts in the archaeological record. The solution here is not, however, to turn away from careful quantitative analysis, as the advocates of 'Structural archaeology' at times seem to advocate, but rather to seek other categories of information with which to supplement these analyses. The so-called 'contextual examination' of the neolithic trade in stone axes in Britain (Hodder and Lane 1982), apparently advocated by Hodder (1982, 207) as some sort of significant methodological advance over previous analyses, appears instead to me to be closely similar in kind to them. With its careful quantitative consideration of shape and size as well as of distribution, it lies in the mainstream of processual thinking along with many other papers in the useful recently edited volumes on trade and exchange (e.g. Earle and Ericson 1977; Fry 1980; Francis, Kense and Duke 1981; Ericson and Earle 1982). Certainly contemporary archaeology is faced with the problem of 'getting inside' early exchange systems in the sense of understanding something of the value systems upon which they were based, but the onus

is upon critics of existing analyses of trading systems to put forward methods of research which take us beyond the already very informative analyses of regional exchange systems which are now available (e.g. Pires Ferreira 1976a and 1976b).

The archaeological study of 'action at a distance' has, in effect, only recently begun, and the two papers here contributed to its inception. The task has, of course, been greatly aided by the availability of appropriate techniques of chemical and physical analysis. This seems indeed to be one of the areas within archaeology where scientific developments in technique have made possible entirely new horizons or interpretation. Trade and exchange can, in consequence, be seen in social terms. This field remains one of the most promising areas of archaeological research.

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